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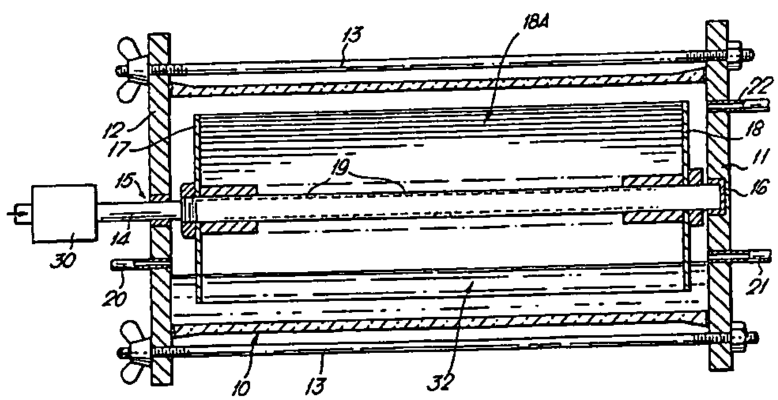
(54) Rotating biological film contactor

(57) A rotating biological film contactor intended for use as a fermenter consists of an elongate horizontal chamber through which extends a rotatable shaft and on the shaft there are mounted spaced support plates 17, with a large number of cords or filaments 18 extending between the plates. Nutrient is flooded into the chamber to partially submerge the assembly of cords and leave an air space above. As the assembly of cords is rotated it cyclically dips into the nutrient and is then exposed to air in the air space above. Micro-organisms adhere to the cords and an adherent culture is built up thereon. Fermentation products can be continuously removed from the nutrient by creating a circulating stream of nutrient through the chamber and recovering the products from that stream.

Fig. 1.



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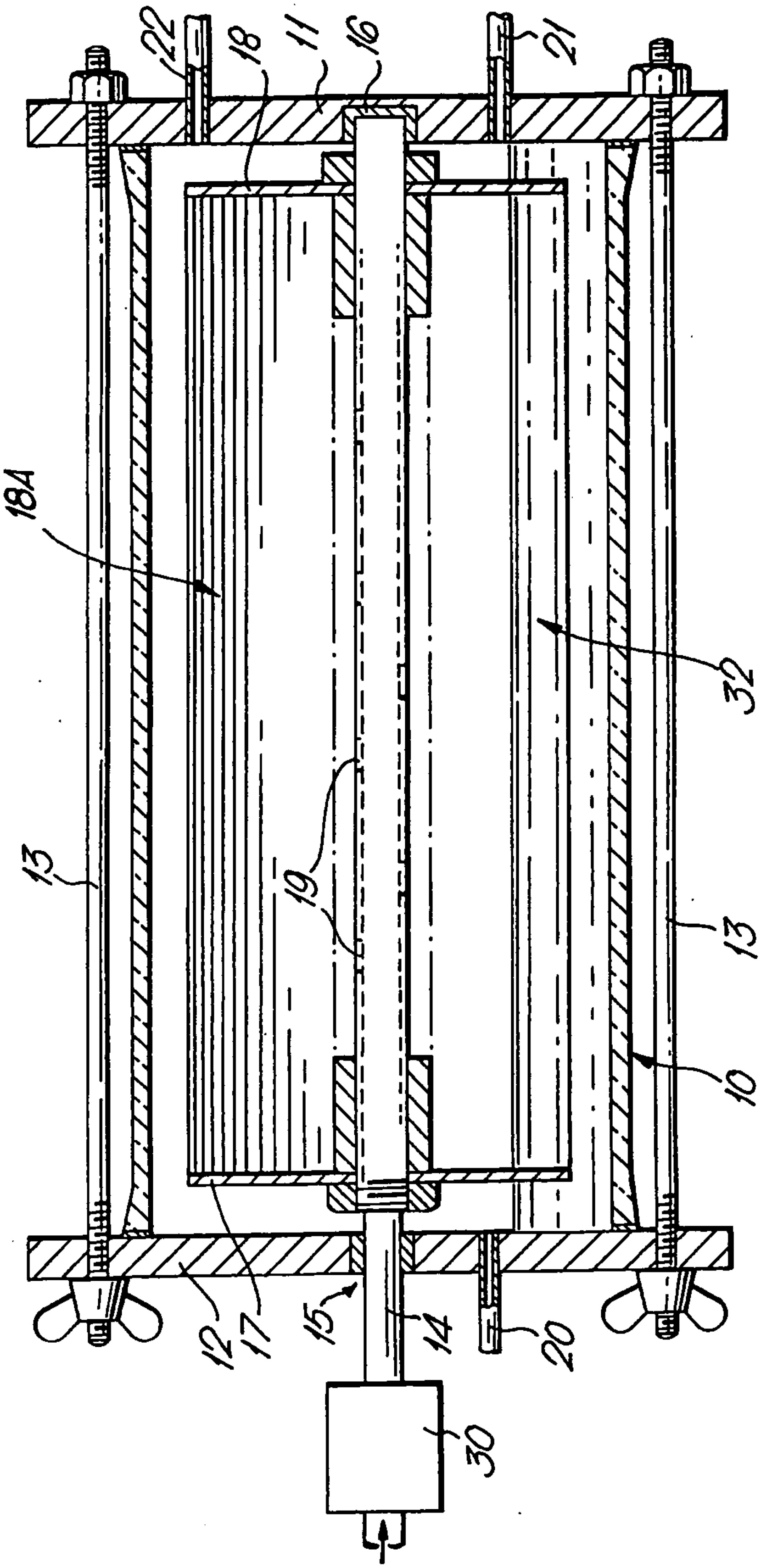


Fig.1.

Fig. 2.

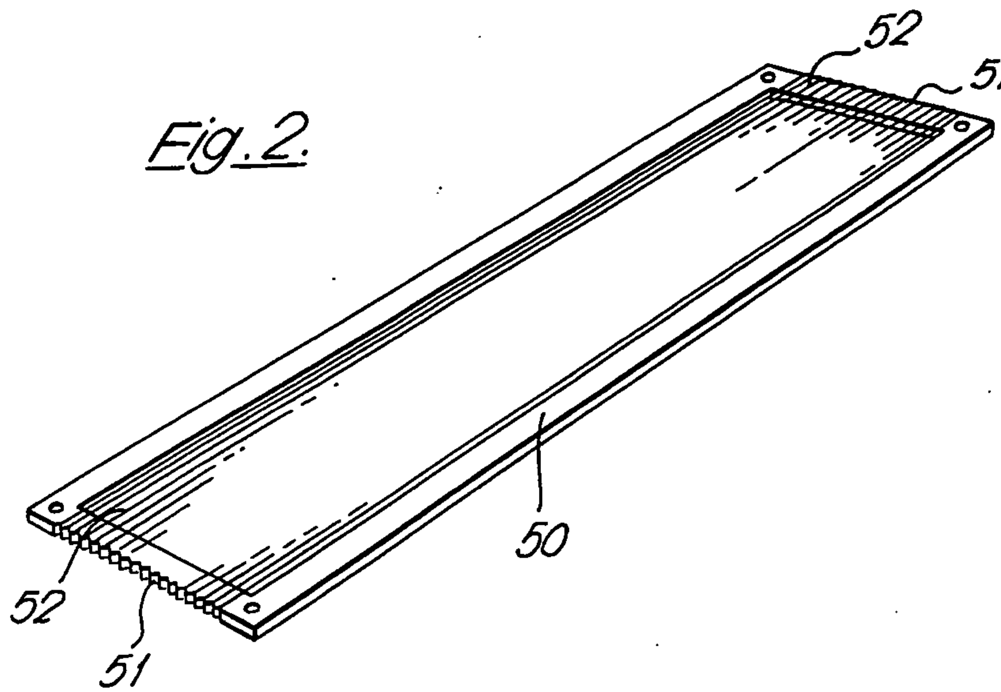
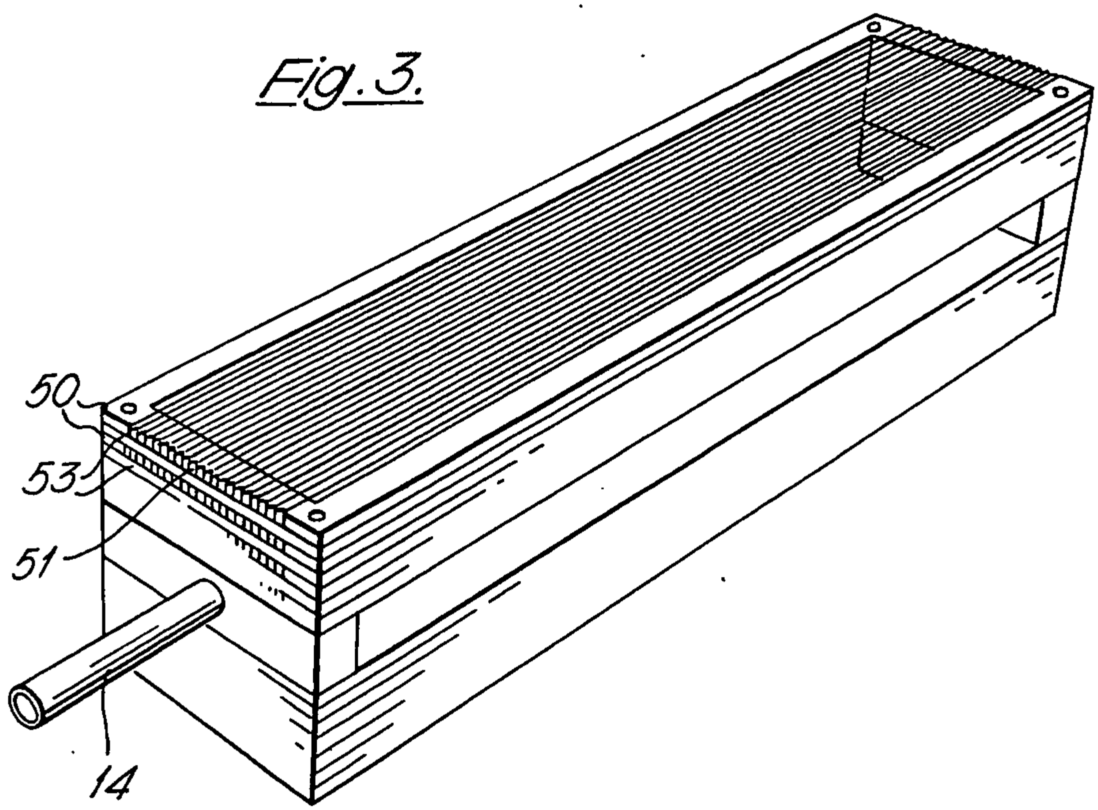


Fig. 3.



SPECIFICATION

Rotating biological film contactor

This invention relates to a rotating biological film contactor.

Various devices have been constructed or suggested in which biological films of randomly-established micro-organisms have been used to treat waste fluids or in which films of specific types of organisms such as animal cells or particular types of micro-organism are grown under conditions where exposure to air and nutrient fluids are important. It is of particular consequence to select appropriate materials which will permit attachment of different types of cell and to design equipment accordingly so that animal cells which grow normally in single layers are given very large surfaces per unit volume, compared to certain microbial cells which may grow in layers many cells thick.

According to the present invention there is provided a rotating biological film contactor comprising a rotatable shaft, spaced support members fixed to and rotatable with the shaft, a multiplicity of filaments extending between the support members, the filaments being generally horizontally disposed, and means for rotating the shaft so that on partial submersion of the support members in a liquid nutrient the cords are cyclically exposed to the liquid and to the air above the liquid as the shaft rotates.

Preferably the contactor includes a generally horizontally disposed vessel through which extends the shaft and within which are located the said plates and cords or filaments. The vessel may have inlet and outlet means for liquid nutrient disposed at levels in end walls of the vessel so as to provide a liquid level ensuring partial submersion of the cords or filaments. The vessel may also have means for providing throughflow of sterile air.

In one embodiment of the present invention a centrally disposed hollow perforate shaft extends through a horizontally disposed cylindrical vessel. Mounted axially on the shaft at or near opposite ends thereof are a pair of circular plates. Between the plates there extends a plurality of cords in parallel spaced relationship one with another. The shaft extends through one end wall of the vessel and locates a bearing in the other wall. The shaft is rotated to rotate the assembly of cords within the vessel and air is delivered to the vessel via the perforate shaft. Means for venting the air are provided as are inlet and outlet means for delivering, and, optionally, creating a circulating flow of nutrient.

The separation between the cords may be as low as one millimetre for growing very thin films such as animal cells or as much as several millimetres for growth of fungal mycelia. The shaft is driven so that the assembly is rotated partly submerged in fluid medium and in the course of one revolution each cord is alternately driven through the fluid and exposed to the atmosphere above the fluid. The biological film is thus able to interact with the fluid and also undergoes the necessary exposure to air.

The invention offers a particular design advantageous for aeration of and liquid contact with a biological film or mat and is adaptable to either thin film growth for animal cells and adherent bacteria or thick mat growth with filamentous fungi. It may be adapted for either sterile operation with pure cell cultures or non-sterile operation with films of filamentous fungi under acid condition which prevent contamination by other organisms or with films of randomly composed mixed micro-organisms as in waste treatment.

The detailed form of the contactor is variable according to the type of cell grown, in selection of cord material and in method of construction of the assembly.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, of which:

Figure 1 is a diagram of a fermenter of this invention;

Figure 2 is a drawing of a single cord frame assembly; and

Figure 3 is a drawing of a stack of the frames shown in Figure 2.

Referring to Figure 1 a fermenter consists of a horizontal standard QVF (Trade Mark) glass cylinder 10, with stainless steel or plastic end plates 11, 12 clamped on to form seals. A central mounted shaft 14 passes through a gland 15 placed centrally in one end plate 12 and fits into a bearing 16 at the other plate 11. The shaft 14 carries at each end a polypropylene rigid disc 17, 18 containing between two and three hundred equidistant perforations (not shown) through which pass terylene cords normally of diameter two millimeters. These cords are taut and lie parallel. A portion of the arrangement of cords is shown in Figure 1 as 18.

The shaft 14 is hollow with perforations 19 so that air pumped in through a tube at the bearing end emerges inside the cylindrical assembly of cords 18 and passes out through the assembly of cords to be voided from a port 22 in the end plate 11 at the other end of the glass cylinder 10.

The end plates 11, 12 also contain ports 21, 22 for fluid addition or removal. The whole apparatus is clamped by screw-ended rods 13.

The fluid 32, normally growth medium for the filamentous fungi selected fills the lower half of the glass cylindrical container. The cord assembly is rotated at low speed (normally about 8 revolutions/minute) by a motor 30.

While it is feasible to make a cord assembly of two or three hundred cords for a small laboratory fermenter as described in respect of Figure 1, for larger scale assemblies for the culture of filamentous fungi, where some thousands of cords may be required, construction would be too laborious and an alternative assembly of cords is necessary.

The same problem arises in tissue culture where to obtain adequate surface area even in a small cultivating device some thousands of fine cords are required.

For either of these uses involving a large number of cords the principle of construction of a cord assembly will now be described with reference to Figures 2 and 3. Rectangular formers 50 of suitable

material such as plastic having serrated ends 51, the spacing of serrations deciding the spacing of cords as does also the thickness of the formers are used to wind a planar cord assembly 52, the formers preferably being revolved mechanically while the cord is fed on from a bobbin. A suitable number of these planar cord assemblies each separated from the other by a cordless former 53 are stacked and bolted together at the corners to give an assembly of square cross section as shown in Figure 3, provision being made for the shaft 14 to pass from the centre of each end of the stack.

This cord assembly can then be used in a horizontal cylinder as described above and in a similar fashion, the diagonal being slightly less than the internal diameter of the cylinder. Provision of aeration etc. would be similar to that hereinbefore described.

CLAIMS

1. A rotating biological film contactor comprising a rotatable shaft, spaced support members fixed to and rotatable with the shaft, a multiplicity of filaments extending between the support members, the filaments being generally horizontally disposed, and means for rotating the shaft so that on partial submersion of the support members in a liquid nutrient the cords are cyclically exposed to the liquid and to air above the liquid as the shaft rotates.

2. A contactor according to claim 1, including a generally horizontally disposed vessel through which extends the said rotatable shaft and within which there are contained the said support members and filaments, the said vessel being capable of holding a reservoir of liquid.

3. A contactor according to claim 1 or 2, in which the support members are a pair of spaced, perforate discs and the filaments are connected to the discs by passage through the perforations.

4. A contactor according to claim 1 or claim 2, in which the filaments are supported by a stack of frames each being wound with a multiplicity of filaments and having serrations to facilitate location of the filaments thereon.

5. A contactor according to claim 1 or 2, in which the shaft is perforated and has means for passing a stream of air through the shaft to exit from the perforations amidst the filaments.

6. A contactor according to claim 5, in which the vessel has means for throughflow of air and for throughflow of liquid.

7. A contactor substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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